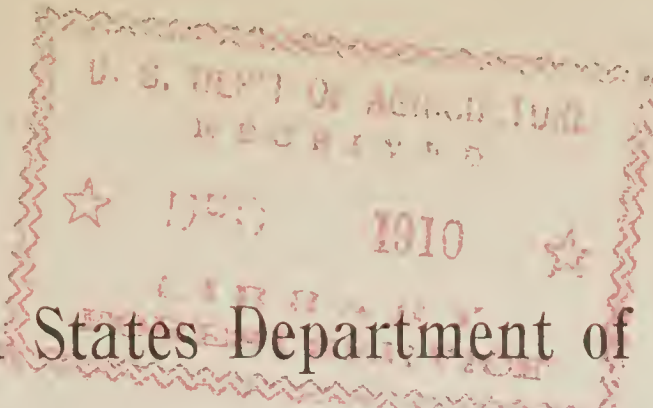


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THE CALIFORNIA GROUND SQUIRREL.

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Ground squirrels are among the most destructive of our native mammals, causing losses to agriculture amounting to upward of ten



FIG. 1.—Douglas and California or Beechey ground squirrels.

millions of dollars each year. Most of the Western States are overrun by them. California is no exception, having within its borders not less than three genera and a dozen species. Of these the most important in its relation to man is the large gray species variously known as the California, Digger, or Beechey ground squirrel (*Citellus beecheyi*). It is about the size of the eastern gray tree squirrel,^a and like it has upright squirrel-like ears and a long bushy tail (fig. 1).

^a Average measurements of the Beechey ground squirrel are: Total length from tip of nose to tip of tail hairs 424 mm. or 16 $\frac{3}{4}$ inches; length of tail to tips of hairs 178 mm. or 7 inches.

It has two near relatives—the Douglas ground squirrel (*Citellus douglasi*), which ranges from the north side of San Francisco Bay northward to the Columbia River; and the Rocky Mountain or Plateau ground squirrel (*Citellus grammurus*), which in California is known only from the canyons of the Colorado River and the Providence Mountains on the east side of the Mohave Desert.

The California ground squirrel, because of the extent of its range, which covers the greater part of the agricultural lands of the State; because of the magnitude of the losses it causes by eating grain, nuts, fruit, and other crops; and because of its dangerous character as a carrier and disseminator of bubonic plague, is, of all our species, the one of greatest consequence to man. The danger to human life by the spread of plague so far exceeds in importance the harm done by the destruction of crops that the duty of checking its increase is no longer merely of local interest but has become a matter of national concern.

RANGE.

The California ground squirrel, as shown on the accompanying map (fig. 2), ranges from Lassen Butte and Susanville in northeastern California southward, east of the Sacramento Valley to San Francisco Bay, and south of the bay overspreads practically the entire State and pushes southward into the peninsula of Lower California, avoiding only the higher mountains and the more arid deserts. Its handsome subspecies *fisheri* inhabits Kern and Owens valleys, the borders of the Mohave Desert, the upper parts of San Geronimo Pass, and other localities in southern California, and occurs as far east as the Coso, Argus, and Panamint mountains.

HABITAT AND HOME.

The Beechey ground squirrel abounds along the ocean shore from San Francisco southward; it inhabits the open plains of the great interior valley of California, the grassy chaparral slopes of the foothills, the rocky walls of canyons, and in places the more open parts of the yellow pine forest of the mountains. It lives in underground burrows which usually are grouped in colonies. The colonies may be located on bare open plains, on the grassy slopes of foothills, or about the roots of trees—particularly the great valley oaks with hollows in their trunks and limbs. The burrows vary in number from a few to hundreds, and by the union of contiguous colonies sometimes reach a total of thousands and cover almost continuously many hundreds of acres. In places they are so near together as to fairly honeycomb the ground. Well-beaten paths, $2\frac{1}{2}$ to 3 inches broad, lead from burrow to burrow and radiate to the adjacent feeding grounds. Many of them extend for considerable distances and by intersecting

form a conspicuous network. The earth brought up from each burrow is deposited at its mouth to form a gradually-enlarging hillock, and colonies on the plain may be recognized at a distance by the mounds.



FIG. 2.—Map showing distribution of Beechey and Douglas ground squirrels.

HABITS.

The animals are diurnal, and in the larger colonies hundreds may be seen at a time, some scudding swiftly over the ground, some rolling in the dust, some basking in the sunshine, and some standing erect on their haunches gazing over the country or biting off the stems of grain, tarweed, or other plants on whose seeds they feed. The seeds

not eaten on the spot are tucked away in the cheek pouches and carried to underground storehouses for future use.

While living mainly on the ground the squirrels are good climbers, and are often seen in oaks and other nut-bearing trees and also in fruit trees and tobacco trees.

They are not migrants in the proper sense of the word, their journeys being limited to short distances, as from one locality to a neighboring one, according to the season and fluctuations in the food supply. Thus at Banning, in San Geronimo Pass, S. E. Piper, of the Biological Survey, found that after the young were large enough to travel many of the squirrels abandoned the grain fields and moved down to the orchards, where they remained during the dry season, to return to the grain fields in winter or early spring. The cultivation of grain or other crops usually draws them from adjoining lands, so that they become more abundant on cultivated lands than elsewhere.

This species does not hibernate, except in the mountains, although in the foothills and valleys the animals usually stay in their burrows during stormy and severe weather. At the upper limit of their range, where the ground in winter is covered with snow, they may remain underground long enough to be said to hibernate, but over the greater part of the State they are out in numbers every month of the year. In the oak foothills, when the acorns are ripening in September and October, these squirrels become fat and lazy, and many may be seen about the mouths of their burrows enjoying the sunshine.

BREEDING.

The time of breeding varies somewhat with the locality, animals living in the north, in the mountains, and along the coast breeding later than those in the hot country.^a The young are usually born in March or early April. Pregnant females have been killed at various dates from February 15 to May 12, and in the warm country young old enough to run about are usually common in April. Now and then small young are seen as late as the middle or latter part of August, indicating that they were born in late June or early July. Whether or not these are cases of a second litter is not known. The number of young at a birth varies from 5 to 11. The average number over the greater part of the State is 8, but along the borders of the Mohave Desert it appears to be reduced to 6 or 7.

FOOD.

The food consists, according to season and locality, of acorns, fruits, seeds of various plants, and green herbage. Acorns are a favorite

^a Thus in the spring of 1910, S. E. Piper reported that at Bakersfield, in the southern part of the San Joaquin Valley, the breeding season was two or three weeks earlier than at Modesto, in the northern part of the same valley; and at Hollister, in San Benito County, it was two weeks later than at Modesto.

food and where obtainable are gathered and stored in large quantities. The same is true of manroot (*Echinocystis fabacea*), the seeds of which are eagerly eaten, according to Piper, from the time they begin to form until fully ripe. At Modesto the squirrels were eating them as early as the middle of May and as late as the middle of December. Other favorite seeds are those of elderberry (*Sambucus*), jimson weed (*Datura*), wild nightshade (*Solanum*), turkey mullein (*Eremocarpus*), tarweed (*Madia*), and numerous grasses. Of cultivated nuts, almonds and walnuts are preferred; of other crops, apples, prunes, peaches, apricots, figs, olives, certain garden vegetables, the seeds of canteloupes, watermelons, and citron melons, and all the grains are eaten wherever they are to be had, and green alfalfa and clover are sometimes taken. In November—sometimes earlier, according to the date on which the early rains begin—tender green vegetation becomes abundant, and the ground squirrels turn their attention to it. At this season their chief food consists of green stuff, mainly young wild oats and filaree, the latter a small member of the geranium family widely distributed in California and valued as a forage plant. In several localities in March the cheek pouches of animals examined by Piper were filled with the yet green seeds of filaree. In June the pouches are often filled with alfalfa leaves and flowers. In southern California the squirrels are fond of the fruit of the prickly pear (*Opuntia*).

STORING FOOD.

Ground squirrels carry, in their ample cheek pouches, acorns, olives, various seeds and grain, and even green stuff, from the places where they are gathered to their burrows, where the acorns and seeds are stored for future use. At Modesto in May, 1909, Piper found stores of alfalaria seeds packed in cavities and well mixed with dry sand. In December of the same year he examined a number of stores of grain unearthed by a farmer while scraping and leveling his land. Each of these caches consisted of from a pint to a quart of oats stored in cavities and packed in dry sand. They varied from 8 to 18 inches in depth beneath the surface; some were in short blind holes; others at the ends of branches of the main burrow.

DEPREDACTIONS.

It is easily seen that an animal so large, so abundant, and so generally distributed over the agricultural parts of the State is capable of inflicting serious losses; and when it is remembered that the ground squirrel feeds on walnuts, almonds, apricots, peaches, prunes, apples, olives, figs, oranges, certain vegetable and forage crops, and all the grains, and also damages vineyards and young orange groves, the magnitude of its depredations, amounting to hundreds of thousands

of dollars annually, can be readily appreciated. Ground squirrels are particularly fond of green almonds and of the pits of green peaches and apricots, eating these from the time the kernel begins to form until the fruit is ripe, thus doing serious damage. They are very destructive to apples also, and in places in the foothills of the Colfax-Auburn region are said to take fully half the crop.

They injure vineyards by gnawing off the young shoots. In the fall of 1907 E. A. Goldman reported that they were doing serious damage to young vineyards about Orosi, in Tulare County, by biting off the leaves and tender shoots of the vines. At first they worked chiefly along the borders of vineyards, proceeding inward as they defoliated the vines, leaving a sharp line of demarcation to show the progress of their invasion. In 1909 S. E. Piper reported that in the case of a 20-acre vineyard planted about 8 miles northeast of Modesto they completely destroyed 5 acres.

At times they injure both almond and orange trees by gnawing the bark. In the orange groves between Portersville and Springville, in Tulare County, it is reported that they occasionally gnaw the bark of the orange trees and sometimes cut the fruit and carry it off.^a

Besides destroying nuts and fresh fruits they attack drying prunes and carry off large quantities.

But the principal money loss attributed to ground squirrels results from their depredations on grain. They devour barley, wheat, and oats when the seed is first sown; they dig up and carry away the sprouting kernels; they invade the fields of ripening grain and feast upon it continuously until harvest time; and when it is cut and stacked they concentrate about the stacks and attack it vigorously, eating all they can and laboring tirelessly to carry the remainder to their underground storehouses. At a single stack near Jamesburg, in Monterey County, a few years ago 300 ground squirrels were caught in traps and many more poisoned; and in July, 1907, Vernon Bailey saw fully 200 about a barley stack at Capistrano, in Orange County. They climbed to the top of the stack and dragged down the grain until it formed a windrow 2 or 3 feet high. At the same place two years later S. E. Piper counted 158 squirrels in sight at one time.

When operating in grain fields, they usually first clear off the grain around the borders of the field, cutting a swath 40 or 50 feet in width, and then establish burrows or colonies of burrows in various parts of the interior.

Another kind of injury inflicted by ground squirrels results from their habit of burrowing in embankments. In the flat country they seek small elevations from which they can better observe the approach

^a An effective method of poisoning them in this region is by cutting oranges in half and smearing the surface over with finely powdered strychnine. These poisoned half oranges are then placed close to the burrows of the squirrels.

of their enemies. Dikes, levees, roadways, and embankments of all kinds attract them and are often seriously undermined by their burrows. In the irrigated districts their underground tunnels, like those of the pocket gophers, frequently cause breaks costing large sums to repair. Thus in May, 1910, ground-squirrel burrows caused such a serious washout in the Turlock Canal in Stanislaus County that the line of the canal had to be changed at a cost of \$25,000. The break occurred during the latter half of May, and the labor of rebuilding the waterway occupied about three months, depriving the ranchmen of water at the very time it was most needed for the irrigation of their alfalfa and other products and entailing a loss of upward of half a million dollars.

NATURAL ENEMIES.

The principal natural enemies of the California ground squirrel are coyotes, badgers, gray foxes, bobcats, weasels, golden eagles, and rattlesnakes.

THE GROUND SQUIRREL AS AN ARTICLE OF FOOD.

Ground squirrels are good to eat and a few years ago were regularly sold in the San Francisco markets. They have always been prized by the Indians, who roast them over the coals and devour them eagerly. Old animals at times have a rather strong flavor, but the young of the year are usually excellent. Recently, however, since the squirrels have been found to be carriers of plague, the Public Health and Marine-Hospital Service has warned the public of the danger of handling the animals.

PLAGUE-INFECTED GROUND SQUIRRELS.

The Asiatic or bubonic plague is now endemic among the ground squirrels in the region immediately east and south of San Francisco Bay. In this area during the past year the Public Health and Marine-Hospital Service has found more than 387 squirrels infected with plague. The squirrels contracted the disease, without doubt, by contact with European rats at the seaport towns about the bay. Ten human cases, of which seven or eight were fatal, resulting from ground-squirrel infection, have been reported.

If funds had been available before the infected squirrels had spread south of San Francisco Bay and east of the San Joaquin River the animals could have been completely exterminated over the infected area. This could have been accomplished at a cost of less than \$100,000 by cutting a broad swath through the ground squirrels' habitat from the south end of the bay easterly to the San Joaquin River, and then working back until they were exterminated over the entire area. But means were not at hand and the disease among the

squirrels has now spread over so large an area that it will be very difficult to wipe it out. The limits of the area are not known, but in the fall of 1909 plague-infected squirrels were found near Hollister, 50 miles south of San Francisco Bay, where in June of the present year (1910) a man died of the disease.

On the south, infected squirrels have been discovered by the Public Health and Marine-Hospital Service near Watsonville, a few miles back of Monterey Bay; near King City in Salinas Valley, and near Tres Pinos and Paicines in San Benito Valley. On the east they have been found near Lathrop and San Joaquin City in San Joaquin County; near Gustine (8 miles south) and Ingomar (8 miles west) in Merced County; and near Crows Landing (6 miles west and 11 miles southwest) in Stanislaus County.

MEANS OF DESTRUCTION.

Among the means of destruction not to be lost sight of is the encouragement of the squirrel's natural enemies—especially coyotes, badgers, foxes, bobcats, and the golden eagle.

Ground squirrels may be shot, trapped, or poisoned, or they may be killed by certain gases forced into their burrows—notably fumes of bisulphid of carbon and burning sulphur.

TRAPPING.

Various traps have been used with success. The ordinary No. 0 steel trap placed unbaited in the mouths of the burrows sometimes yields excellent results, but the best and most humane trap in use at the present time is the so-called guillotine trap—a trap which kills the animal instantly by striking it a heavy blow on the back of the neck. Any food attractive to the squirrels may be used for bait; grain, rolled oats, dried prunes, and pieces of sugar beet have proved successful.

POISONING.

In places where ground squirrels are abundant over considerable areas the simplest, most effective, and least expensive way to destroy them is by the use of grain poisoned with strychnine.

Phosphorus and cyanide of potassium, owing to the great danger attending their use, are not recommended, especially since they are not more effective than strychnine.

In poisoning with strychnine, the grain recommended for bait is barley. Compared with wheat, it is usually more attractive to the squirrels and is far less likely to be eaten by birds.

There are two distinct methods of preparing the poisoned grain: (1) By soaking or boiling in the poison solution; (2) by coating with the poison solution. The Biological Survey, in extensive experiments in various parts of California conducted by S. E. Piper, has found that

coated grain, except during the rainy season, yields far better results than soaked grain, and kills the animals more quickly, so that they are much more likely to die above ground, where they can be seen. The success of poisoning with coated grain is due largely to the squirrel's habit, during the dry season, of gathering seeds and carrying them home in its cheek pouches. The cheek pouches are muscular sacs, one on each side of the jaw and throat, each large enough to hold about 200 kernels of barley. Much of the food carried in the cheek pouches is not eaten at the time, but taken to underground storehouses where it is kept for winter use. When grain coated with a properly prepared strychnine solution is carried in the pouches, enough of the poison is dissolved and absorbed to kill the animal at once. Piper made the important discovery that strychnine is far more quickly absorbed by the cheek pouches than by the stomach, and



FIG. 3.—Result of poisoning 6 acres at Capistrano.

that one-fifth the quantity necessary to kill by the stomach will kill when taken into the pouches. It follows that *coated* grain, which carries the poison on the outside, acts much more promptly than *soaked* grain, which carries the poison in its interior and must be ground by the teeth, swallowed, and partly digested before it can act. A practical advantage of the coated grain is that a large percentage of the squirrels are overcome by the poison while still engaged in gathering the scattered kernels and die before entering their holes. This may seem a trifling matter, but ranchmen using the poison are greatly encouraged when they can see the result of their labors.

The accompanying illustration (fig. 3) shows 115 dead ground squirrels picked up on a 6-acre field at Capistrano, Orange County, August 23, 1909, a few hours after putting out 20 pounds of barley coated with the starch-strychnine preparation. About 50 turkey

buzzards gathered and gorged themselves on the dead squirrels, not one of which was left by the following night. The buzzards were not injured.

An equally striking case is that of the poisoning of a 25-acre tract in the Cleveland National Forest, just south of San Geronio Pass, with 40 pounds of starch-strychnine coated barley. A few hours afterwards 240 dead squirrels were counted.

It should be remembered that in these and all cases of strychnine poisoning the animals that die outside are only a part of those killed, for a much greater number die in their burrows and are never seen.

PREPARING THE POISON.

Following is the formula perfected and recommended by the Biological Survey:

Starch-strychnine formula for coating grain.

Barley, clean grain, free from other seeds.....	20 quarts
Strychnia sulphate (ground or powdered).....	1 ounce
Saccharine	1 teaspoonful
Gloss starch (ordinary laundry starch)	$\frac{1}{2}$ teacupful
Water.....	$1\frac{1}{2}$ pints

Dissolve the starch in a little cold water and add $1\frac{1}{2}$ pints of boiling water, making a rather thick solution. While hot, stir in the strychnine and mix until free from lumps; then add the saccharine and beat thoroughly. Now pour the poisoned starch over the barley and stir rapidly until the poison is evenly distributed; then allow the grain to dry. When dry it will keep indefinitely without deterioration.

For ordinary quantities a galvanized-iron washtub is an excellent receptacle in which to mix the grain with the poisoned starch; but when large quantities are needed the mixing may be done in a water trough with a shovel and hoe.

PUTTING OUT THE POISON.

The poisoned grain should be scattered (not placed in heaps) on clean hard places about the colonies—on the squirrel trails between the holes, along fences and roadsides, and in other places frequented by the squirrels. Poisoned grain falling in soft dust or in foxtail grass or other dense cover is wasted.

THE BEST TIME TO POISON GROUND SQUIRRELS.

A weighty factor in determining the success or failure of poisoning operations is the time of year at which the work is done. The best season for poisoning is the dry season. This varies in duration from year to year, but on the average begins in April and continues until the middle or end of October.

Many ranchmen put off poisoning until the early part of the rainy season—in December and January. This is the least favorable part of the year, for the triple reason that (1) the animals are not out in full numbers; (2) the poisoned grain, owing to the abundance of fresh green food, is less likely to be eaten; and (3) the rains waste the grain by burying it or washing off the poison so that the cost and labor of putting it out are often lost. During the dry season, on the contrary, the squirrels are out in full numbers, green food is scarce, and any poisoned grain that may not have been eaten when first put out retains its effectiveness for weeks and months, so that at any time it may kill such squirrels as at first failed to find it, or such squirrels from outside as may later invade the poisoned area.

Ground squirrels may be poisoned to advantage also during the breeding period, which usually falls about the end of the rainy season, in late March and early April. At this period—extending from before the birth of the young until they are old enough to come out of the burrows—the destruction of 100 mothers is equivalent to the killing of 900 animals later on.

It is popularly believed that ground squirrels can not be successfully poisoned in stubble fields after harvest in summer because of the abundance of scattered grain. This is incorrect, for the squirrels habitually search for scattered grain and quickly pick up any they find near the runways or burrows. Some of the most successful experiments made by the Biological Survey have been in stubble fields where scattered grain was plentiful.

Treatment of stubble fields with the starch-barley preparation at any time between harvest and the beginning of the rains is likely to prove successful.

COST.

In exterminating ground squirrels the most economical method is first to use the starch-strychnine preparation, and later to kill the few remaining animals by using bisulphid of carbon in the burrows that are still occupied.

The cost of barley coated with the starch-strychnine preparation varies from about \$4 to \$4.75 per 100 pounds, according to the price of the barley and the strychnine; and 100 pounds of the poisoned grain is sufficient to treat from 200 to 300 acres, according to the abundance of the squirrels. Assuming that 100 pounds of poisoned barley cost \$4.50, and adding \$2 for labor (1 day) and \$1 for hire of saddle horse (in case the grain is distributed from horseback), the total cost of poisoning say 250 acres would be only \$7.50, or 3 cents per acre.

The animals that do not eat the poisoned grain, or for any reason escape, may be killed with bisulphid of carbon at the rate of 1½ cents per occupied burrow.

WINTER POISONING.

Poisoning during the rainy season with means thus far tested is disproportionally expensive and should not be resorted to except in cases of extreme necessity.

In the experiments carried on by the Biological Survey at Modesto, in Stanislaus County, Piper found that in November, after the winter rains had set in, the squirrels had ceased storing food and no longer carried the grain away in their cheek pouches, but hulled it on the spot and ate the kernel, casting off the outside and thus escaping the poi-



FIG 4.—Ground squirrels killed by poisoned green barley heads at mouth of burrow.

son. By scattering the grain widely the difficulty was in part overcome, for the squirrels rarely stopped to eat a single kernel, but first gathered a number and carried them to the mounds at the mouths of their burrows, and while so engaged were killed by the poison (fig. 4). Nevertheless, at Modesto, during the wet season, the starch-barley poison proved far less reliable than during the dry season. This was due partly to the squirrel's change in habit—in ceasing to store food—and partly to the frequent rains, which washed off the poison. In other localities—notably about Fresno and Bakersfield—it was entirely successful in winter.

WHEAT FOR WINTER POISONING.

Wheat, since it has no outer hull to be removed by the squirrels, is better than barley for winter poisoning. It must be remembered, however, that poisoned wheat is very destructive to birds, particularly meadowlarks, doves, quail, and the smaller seed-eaters, so that great care is necessary in distributing it. If put out in the early morning close to the holes it is likely to be eaten by the squirrels before the birds find it. During the spring of 1910 poisoned wheat was used with good results in Riverside County by placing it in the squirrel holes.

Formula for poison wheat.

Wheat (clean)	25-30 pounds
Strychnine (alkaloid, powdered).....	1 ounce
Saccharine	1 teaspoonful
Mucilage of gum tragacanth	1 quart

Boil a small quantity of gum tragacanth in $1\frac{1}{2}$ pints of water to make a medium thick paste. When cool, add the strychnine and saccharine and mix thoroughly. Pour the poisoned paste over the wheat and stir until evenly distributed. Then spread the wheat and allow it to dry before using. Gum arabic may be used instead of tragacanth. The advantage of tragacanth over starch is that it is more resistant to moisture and therefore better for winter use.

POISONING WITH GREEN BARLEY HEADS.

Of the various baits experimented with in southern California, green barley heads proved most irresistible to the squirrels. During June and July, 1909, they were used with marked success at Banning, in an area of 8,000 acres in and adjacent to the orchard district. Here the squirrels were feeding on green grain and green almonds and doing a vast amount of damage.

In selecting barley heads for this purpose the grain should be in the paste or ripening stage, and the long beards should be snipped off with scissors. They should then be immersed in a solution made by dissolving one ounce of strychnia sulphate in a gallon of boiling water to which a teaspoonful of saccharine has been added. When the solution is cool, as many trimmed barley heads should be put into it as the liquid will cover, and they should be allowed to soak for fifteen or twenty hours.

The poisoned heads should be distributed in the early morning so that they may be eaten before drying. Two or three should be placed near each hole inhabited by adult squirrels, and six or eight in the case of families of young, as each squirrel is likely to eat an entire head before the poison takes effect. It is probable that green heads can be successfully coated with the starch-strychnine preparation, but this has not yet been done.

While no accidents to stock have resulted from this method of poisoning, care should be exercised in distributing it in places accessible to stock, particularly if feed is scarce.

BISULPHID OF CARBON.

Crude bisulphid, suitable for killing ground squirrels, prairie dogs, and other burrowing animals, costs about 8 cents per pound in 50-pound carboys or drums. It is a volatile liquid and rapidly loses strength on exposure to the air; hence, it should be kept in tightly corked bottles or cans. It should not be introduced haphazard, but should be used only in burrows where the animals have been seen to enter immediately before it is applied, so that none may be wasted. It should be employed in the following manner:

A tablespoonful of crude bisulphid should be poured on a piece of horse manure, corncob, cotton waste or other absorptive material; this should be thrown as far as possible down the burrow and the opening closed immediately. Bisulphid can be used to best advantage after a rain, when the interspaces in the soil are filled with water, so that the fumes are less readily diffused into the surrounding ground.

In colonies where the holes are close together half an ounce of the bisulphid is enough for each burrow, but in the case of solitary burrows a full ounce should be used.

In a field demonstration conducted by the Biological Survey, 492 holes were treated with bisulphid. The quantity used was $3\frac{1}{2}$ gallons, and two men were employed for one day in putting it out. Every squirrel in the colony was killed.

TARRING CORN AGAINST GROUND SQUIRRELS.

Seed corn may be protected by tarring with coal tar. At Pala, in southern California, during the season of 1909 a field of corn planted by Mr. Lonergan, superintendent of the Pala Reservation, was almost wholly destroyed by ground squirrels. A second planting (July 5-8) was treated with coal tar. The squirrels did not touch it, and the corn made a perfect stand.

REMARKS.

Some ranchmen still persist in using phosphorus or potassium cyanide preparations. These are no more effective than the starch-strychnine poison and their preparation and use are attended with grave dangers both to man and to farm animals. Potassium cyanide increases the danger to stock and birds without adding to the effectiveness of strychnine. Phosphorus is extremely fatal to swine, and in addition is liable, under certain conditions, to glow spontaneously with a red heat and kindle fires. Fires started in this

way have destroyed extensive fields of grain, and have burned fences and farm buildings.

Deplorable destruction of birds has followed poisoning with both cyanide and phosphorus, and also with strychnine when used on wheat, oats, and Egyptian corn; but so few birds will eat coated barley that scarcely half a dozen, all told, have been found dead after poisoning many thousands of acres with the starch-barley preparation.

The methods of poisoning herein recommended are not dangerous to stock, and may be safely employed on pasture lands, sheep ranges, and public highways, but should not be practiced in places accessible to poultry.

The most disheartening feature of ground-squirrel poisoning is that lands which have been freed from squirrels are likely to be repopulated from adjacent lands which have not been poisoned. This is due to the extreme difficulty of arousing all the landowners of a neighborhood to unite in joint action in order to destroy all the squirrels. It is this lack of cooperation that keeps up the supply and levies an unjust tax on those ranchmen who periodically kill off the pests in their own fields and orchards.

If the inhabitants of a district would unite in a cooperative campaign against the squirrels, or if the county supervisors or other authorized officials would undertake the task, including in their jurisdiction the public lands and highways, which are notorious sources of infestation, the animals could be exterminated over large areas, and the ranchmen and orchardists would enjoy a long period of immunity from squirrel depredations.

